Criteria for Identifying and Evaluating Effectiveness of Barriers

(updated 4/30/2002)

Table of Contents

Criteria for Identifying and Evaluating Effectiveness of Natural Barriers

Introduction

Determining source water susceptibility is a mandatory component of a source water assessment as required by the SDWA and the Montana Source Water Protection Program. Susceptibility is based on the proximity or density of potential contaminant sources relative to the source water and whether barriers exist that may decrease the likelihood that contaminants will reach a water intake. This guidance sheet describes barriers and their application that can be used under the Montana Source Water Protection Program. **Barriers that do not meet the criteria described here will not be considered.** Evidence of barriers described in an assessment must be presented to be considered.

Barriers can be natural conditions, engineered structures, or management actions. Susceptibility ratings are determined individually for point sources and collectively for non-point sources. SWDARs must include a table listing all significant potential contaminant sources identified in the inventory and their associated hazard and relative susceptibility ratings. A narrative describing the presence of barriers for each significant potential contaminant source must accompany the table showing hazard and susceptibility.

I. Natural Barriers for Groundwater Sources

Potential Source	Barrier	Measure
All Sources	Continuous Clay Layer	Thickness and Hydraulic Conductivity
-	Dilution and Mixing (not for microbial contaminants)	Volume and concentration of contaminant source and background
-	Vertical Flow Direction	Hydraulic Gradient
-	Natural Attenuation	Properties of contaminant and soil and aquifer materials, unsaturated zone thickness

(NOTE: for susceptibility ranking at wells tapping a confined aquifer, consideration of natural barriers occurs when applying Table 6 (MT SWPP), therefore, caution should be exercised to ensure credit for natural barriers is not considered twice.)

A. Vertical Flow Rate

Unsaturated Zone greater than 100 feet thick.

Continuous clay layer with (Hydraulic Conductivity ÷ Thickness) < 1 X 10^{-3} day^{-}.

B. Dilution and Mixing

Dilution sufficient to reduce water quality impacts to nonsignificant levels as defined in ARM Title 17, chapter 30, subchapter 7.

C. Vertical Flow Direction

Hydraulic gradient indicating upward flow under all conditions including maximum pumping.

D. Natural Attenuation

Chemical transformation, biological degradation, adsorption or other chemical or physical processes that reduce water quality impacts to nonsignificant levels as defined in ARM Title 17, chapter 30, subchapter 7. Chemical-specific parameters such as soil-water partition coefficients, water solubility, Henry's law constant, air diffusivity, and water diffusivity should be considered when evaluating attenuation. Attenuation of metals from soils should be evaluated using an equilibrium geochemical speciation model.

II. Natural Barriers for Surface Water Intakes (Direct Discharge)

Potential Source	Barrier	Measure
All except sources of microbial contaminants	Dilution and Mixing	Volume and concentration of contaminant source and receiving water
All except sources of microbial contaminants	Filtration and Degradation	Presence of Riparian vegetation

A. Dilution and Mixing

Dilution sufficient to reduce water quality impacts to nonsignificant levels as defined in ARM Title 17, chapter 30, subchapter 7.

B. Filtration and Degradation

Forested riparian zone > 50 ft. wide.

Criteria for Identifying and Evaluating Effectiveness of Engineered, Management, and Treatment Barriers

I. Engineered, Management, and Treatment Barriers for Ground Water Sources

Potential Sources	Barrier	Measure
All Potential Contaminant Sources	Well Intake Depth	Well intake depth > 50 feet below the mean water table elevation.
Septic Systems	Growth Management	Zoning and Subdivision Restrictions
-	Advanced Treatment	> 50% of households
-	Community Septic Systems	>50% of households
Cropped Agricultural Land	Spill Prevention	Impermeable mixing stations with Spill Catchment
-	Non-point Pollution Reduction	Chemical Application BMPs
Storm Sewer Outflows	Waste Recycling and Minimization	Hazardous waste chemical collection and education
Significant Point Sources	Spill Prevention	Chemical Handling Procedures
-	Spill Catchment	Containment for maximum probable spill
-	Leak Detection	Monitoring wells
Class V Injection Wells	Inventory	Inventory of location and waste analysis on file with sanitarian
-	Waste Recycling and Minimization	Hazardous waste chemical collection and education
Highways and Railways	Emergency Response Planning	Formal communication and spill response protocols
-	Transport Restrictions	Ordinance restricting transport of hazardous chemicals
Animal Feeding Operations	Manure Storage and Disposal BMPs	Manure management plan in place
Wastewater Treatment/ Spray Irrigation/Lagoons	Restrict Land Application	Limit to agronomic rates
-	Leak Prevention	Lined lagoons

II. Engineered, Management, or Treatment Barriers for Surface Water Intakes

Potential Source	Barrier	Measure
All Sources in the Control Zone	Well Construction	Meet requirements of Board of Water Well Contractors
Stormwater Runoff	Sediment Filter	Discharge >100 ft. from perennial streams
Septic Systems	Growth Management	Zoning and Subdivision Restrictions
-	Advanced Treatment	> 50% of households
-	Community Septic Systems	>50% of households
Significant Point Sources	Spill Prevention	Redundant
-	Spill Catchment	Containment for maximum possible spill
-	Leak Detection	Monitoring wells
Wastewater Discharges	Waste Recycling and Minimization	Hazardous waste chemical collection and education
Highway and Railway Crossings	Emergency Response Planning	Formal communication and spill response protocols
-	Transport Restrictions	Ordinance restricting transport of hazardous chemicals
Pipeline Crossings	Spill Prevention	Active System Integrity Inspection program
-	Spill Catchment	Ability to isolate leaks
-	Leak Detection	Ability to locate and isolate leaks
-	Emergency Preparedness	Formal communication and spill response protocols
Animal Feeding Operations	Runoff Diversion – Prevent runoff from entering CAFO	Shelterbelt, irrigation ditch, cropland
-	Runoff Diversion - Collection and infiltration of runoff from CAFO	Containment for a 25-yr, 24-hr rainfall event
-	Manure Storage and Disposal BMPs	Manure management plan in place
-	Riparian Grazing Management	Limits on number or timing of livestock allowed to graze
Wastewater Treatment/ Spray Irrigation/Lagoons	Restrict Land Application	Limit to agronomic rates
-	Leak Prevention	Lined lagoons
-	Runoff Collection	Containment for a 25-yr, 24-hr rainfall event plus contents
Cropped Agricultural Land Use	Spill Prevention	Chemical mixing BMPs
-	Non-point Pollution Reduction	Chemical Application BMPs
Logging	Streamside Buffer	>100 ft. from perennial streams
Microbial Contaminants	Disinfection	Maintain chlorine residual

Procedures for Determining and Reporting Susceptibility

The following are **examples** of the information required for a susceptibility assessment. A narrative describing the basis for the hazard rating and effectiveness of barriers similar to that following the tables should accompany a susceptibility analysis.

I. Hypothetical Susceptibility Assessment: Surface Water Intake

Contaminant Source	Contaminant	Hazard Rating	Barriers	Susceptibility
Highway Crossing	VOC, SOC	High	None	Very High
Animal Feeding Operation	Nitrate	High	Runoff Diversion	High
Animal Feeding Operation	Microbial Contaminants	High	Runoff Diversion, Disinfection	Moderate
Above Ground Storage Tank	VOC	Moderate	Spill Catchment	Moderate
30% Cropped Agriculture	SOC	Moderate	Thick Clayey Soils	Moderate
Leaky Underground Storage Tank	VOC	Low	None	Moderate
Underground Storage Tank	VOC	Low	Spill Catchment, Leak Detection	Low

Highway Crossing - Hazard is ranked high because spills of large quantities of chemicals may have acute health effects. Susceptibility is ranked very high because there are no barriers to prevent contaminants from flowing to a surface water intake and there is insufficient time to implement emergency procedures..

Animal Feeding Operation - Hazard is ranked high because nitrate and microbial contaminants from animal wastes that accumulate in the feedlot are associated with acute health affects. Susceptibility for nitrate is ranked high instead of very high because best management practices are implemented to reduce and control runoff from the CAFO. Susceptibility for microbial contaminants is ranked as moderate because of the additional barrier of disinfection.

Above Ground Fuel Storage Tank - Hazard is ranked as moderate because a spill from the tank can flow directly to the surface water source. Hazard is not ranked high because petroleum products are not associated with acute health effects at the quantities expected to occur. Susceptibility is ranked as moderate because there is sufficient secondary containment to hold the contents of the tank.

Cultivated Cropland – Hazard is ranked moderate because greater than 20% of the spill response region is cultivated cropland. Susceptibility is ranked low because thick clayey soils should limit infiltration of contaminants.

Leaky Underground Storage Tank – Hazard is ranked low because the potential contaminant cannot discharge directly to the source water and is not associated with acute health effects. Susceptibility is ranked moderate because there are no effective barriers.

Underground Storage Tank – Hazard is ranked low because a spill cannot discharge directly to the source water and the potential contaminant is not associated with acute health effects. Susceptibility is ranked low because the tank has been replaced within the last fifteen years and has secondary containment and leak detection systems.

II. Hypothetical Susceptibility Assessment: Unconfined Ground Water Source

Contaminant Source	Contaminant	Hazard Rating	Barriers	Susceptibility
Highway ROW	VOC, SOC	High	None	Very High
Animal Feeding Operation	Nitrate	High	Runoff Diversion	High
Animal Feeding Operation	Microbial Contaminants	High	Runoff Diversion, Disinfection	Moderate
Above Ground Storage Tank	VOC	Moderate	Spill Catchment	Moderate
30% Cropped Agriculture	SOC	Moderate	Thick Clayey Soils	Moderate
Leaky Underground Storage Tank	VOC	Low	None	Moderate
Underground Storage Tank	VOC	Low	Spill Catchment, Leak Detection	Low

Highway ROW - Hazard is ranked high because the highway right of way passes within the 1-year time of travel (TOT) zone of the well and applied or spilled chemicals can migrate to the unconfined aquifer. Susceptibility is ranked very high since there are no barriers to contamination. The fact that the well construction meets current standards (including grout to 25 feet) is only considered to be a barrier where it prevents inter-aquifer leakage. A single barrier can be achieved by developing a formal emergency spill response plan.

Animal Feeding Operation - Hazard is ranked high because the facility is within the 1 year TOT for the well. Susceptibility for nitrate is ranked very high because best management practices to reduce and control runoff from the CAFO do not prevent infiltration to the shallow ground water. Susceptibility for microbial contaminants is ranked as high because of the barrier of disinfection applied to the drinking water source.

Above Ground Fuel Storage Tank - Hazard is ranked as moderate because a spill from the tank located between the 1 and 3 year TOT can infiltrate the ground and contaminate the aquifer. Susceptibility is ranked as low because there is sufficient secondary containment to hold the contents of the tank.

Cultivated Cropland – Hazard is ranked moderate because greater than 20% but less than 50% of the inventory region is cultivated cropland. Susceptibility is ranked low because agricultural producers have formally agreed to utilize standard BMPs when applying chemicals and fertilizers.

Leaky Underground Storage Tank –Hazard is ranked as moderate because the leaky tank is located between the 1 and 3 year TOT. Susceptibility is ranked as moderate because the site is under a formal remediation plan and ground water monitoring is in place to ensure in-situ bio-remediation is occurring.

Underground Storage Tank – Hazard is ranked as moderate because the tank is located between the 1 and 3 year TOT. Susceptibility is ranked low because the tank has been replaced within the last fifteen years and has secondary containment and leak detection systems.

III. Hypothetical Susceptibility Assessment: Confined Ground Water Source

The following is an example of the information required for a susceptibility assessment of a confined ground water system. For this example, the two PWS wells tap the confined aquifer and are flowing artesian. The well logs clearly document that annular space is grouted into the confining layer 500 feet below ground surface. The PWS operates off of closed-in artesian pressure. There are numerous domestic wells tapping a shallow unconfined aquifer but none penetrate the confining layer within the 1000-foot radius inventory zone.

Contaminant Source	Contaminant	Hazard Rating	Barriers	Susceptibility
Highway ROW	VOC, SOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Animal Feeding Operation	Nitrate	Low	Protective Vadose Zone, Upward Flow	Very Low
Animal Feeding Operation	Microbial Contaminants	Low	Protective Vadose Zone, Upward Flow	Very Low
Above Ground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low
30% Cropped Agriculture	SOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Leaky Underground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Underground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low

For all identified contaminant sources - Hazard is ranked low because all wells penetrating the confining layer within the inventory region are grouted. Susceptibility is low because multiple barriers are identified which include 1) the depth to the top of the aquifer exceeds 100 feet and 2), the upward gradient under all conditions.

IV. Hypothetical Susceptibility Assessment: Confined Ground Water Source

The following is an example of the information required for a susceptibility assessment for wells tapping what is described as a deep confined ground water system in . For this example, the two PWS wells tap the confined aquifer. The well logs clearly document that annular space is grouted into the confining layer 500 feet below ground surface. The PWS operates off of closed-in artesian pressure. There are numerous domestic wells tapping a shallow unconfined aquifer but none penetrate the confining layer within the 1000-foot radius inventory zone.

Contaminant Source	Contaminant	Hazard Rating	Barriers	Susceptibility
Highway ROW	VOC, SOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Animal Feeding Operation	Nitrate	Low	Protective Vadose Zone, Upward Flow	Very Low
Animal Feeding Operation	Microbial Contaminants	Low	Protective Vadose Zone, Upward Flow	Very Low
Above Ground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low
30% Cropped Agriculture	SOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Leaky Underground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low
Underground Storage Tank	VOC	Low	Protective Vadose Zone, Upward Flow	Very Low

For all identified contaminant sources - Hazard is ranked low because all wells penetrating the confining layer within the inventory region are grouted. Susceptibility is low because multiple barriers are identified which include 1) the depth to the top of the aquifer exceeds 100 feet and 2), the upward gradient under all conditions.